Nebraska Public Power District
Gerald Gentleman Station

Project No. 12681-006
10/14/2011, Rev 4

Response to Action Item No. 0451 – Discussion on Options for Bleed Stream for FGD

I. Introduction

NPPD is evaluating the potential for retrofitting wet FGD systems to Gerald Gentleman Units 1&2. The new FGD systems will be based on forced oxidation and will produce a gypsum byproduct. Based on available material design options, it is has been determined that the chloride concentration within the scrubber loop will be maintained at 30,000 ppm. Although the bleed stream at this chloride level is expected to be very small, some bleed from the hydroclone overflow may still be needed to purge the FGD system of chlorides, limestone inerts, and other constituents to maintain an equilibrium chloride concentration of 30,000 ppm in the absorber..

This report is a follow-up to the previous report that was submitted to NPPD on December 31, 2009 (S&L #251). When the previous report was prepared, two absorber chloride levels (12,000 ppm and 30,000 ppm) were still being considered and a number of treatment and disposal options were identified that could be appropriate based on these levels. Since the previous report was issued, it has been determined that the design chloride level will be 30,000 ppm. Although some mass balances were previously prepared based on 30,000 ppm chloride, these mass balances have since been refined. Additionally, NPPD has had the opportunity to further evaluate the environmental impacts of any discharges and opportunities for disposal and/or reuse within the power plant. NPPD's letter to S&L dated August 15, 2011 (NPPD #285) specifically requests that the following three options be considered in the revised study report:

- Option 1 – Fuel chloride level is sufficiently low that the water leaving with the gypsum provides sufficient bleed and no supplemental bleed is required.
- Option 2 – Fuel chloride level requires a bleed that is small enough to allow disposal by reuse in the damp fly ash unloading system. This option should include use of the existing hydrobins for storage of the bleed stream.
- Option 3 – Fuel chloride level requires a bleed that is too large to allow all of the wastewater to be reused in the damp unloading system and a zero liquid discharge system is required to treat the remainder.

The purpose of this report is to refine the information developed in the previous report and address the three specific options for disposal, reuse and/or treatment of the FGD bleed stream that have been identified by NPPD.

II. Design Basis

S&L has developed revised FGD mass balances based on the following design parameters:

Fuel Sulfur Content	0.28%, 0.75% and 1.00%
Fuel Chlorine Content	0.005%, 0.01%
Absorber Chloride Concentration	30,000 ppm
Absorber Bromide Concentration	Negligible

In response to NPPD's concerns about the potential for release of bromine from the brominated activated carbon upstream of the wet FGD system, we have investigated this issue and concluded that the bromine molecule is impregnated in the carbon particle and remains stable and inert. Therefore, little or no bromide, which could potentially impact allowable chlorides, is expected to be present in the absorber slurry. If a fuel additive is used in conjunction with activated carbon there could be an issue, however there is not a lot of data to support that the equilibrium chloride concentration in the FGD would be impacted.

The fuel chlorine content may be slightly lower or higher than the design basis depending on the specific mine from which the fuel is obtained. Additional fuel sampling using more sensitive analytical techniques should be performed to better define the fuel chloride levels. Additional fuel sampling will be performed as part of another NPPD project that includes baseline testing at Gerald Gentleman Station. After the sampling has been completed and the results are available, the design basis could be revised accordingly, if appropriate. The mass balance summaries in Attachment A illustrate the bleed rate as a function of these three key parameters. The results are also summarized in the tables below. These tables show bleed rates per unit required for an absorber chloride concentration of 30,000 ppm with varying fuel sulfur content. The first table is based on a fuel chlorine content of 50 ppm and 30 ppm of chloride in the well water makeup. The second table is based on a fuel chlorine content of 100 ppm and 100 ppm of chloride in the well water.

	50 ppm Fuel Chlorine, 30 ppm Makeup Water Chloride
Fuel Sulfur Content	
0.28% Fuel Sulfur	1 gpm
0.75% Fuel Sulfur	(4) gpm
1.0% Fuel Sulfur	(6) gpm

	100 ppm Fuel Chlorine, 100 ppm Makeup Water Chloride
Fuel Sulfur Content	
0.28% Fuel Sulfur	6 gpm
0.75% Fuel Sulfur	1 gpm
1.0% Fuel Sulfur	(1) gpm

As indicated, the bleed rate can vary depending on the fuel sulfur and chlorine contents.. However, the results support the three options identified by NPPD, which can be further defined as follows:

- Option 1 (0 gpm bleed) – With 50 ppm fuel chlorine and 30 ppm makeup water chloride, fuel sulfur content above 0.37 %. With 100 ppm fuel chlorine and 100 ppm makeup water chloride, fuel sulfur content above 0.9%
- Option 2 (1 gpm bleed per unit, 2 gpm total) – With 50 ppm fuel chlorine and 30 ppm makeup water chloride, fuel sulfur content ranging between 0.28 % to 0.75%. With 100 ppm fuel chlorine and 100 ppm makeup water chloride, fuel sulfur content ranging between 0.75 % to 0.9%.
- Option 3 (6 gpm bleed per unit, 12 gpm total) – With 50 ppm fuel chlorine and 30 ppm makeup water chloride, a bleed rate of 6 gpm would not be required, regardless of fuel sulfur content. With 100 ppm fuel chlorine and 100 ppm makeup water chloride, fuel sulfur content ranging from 0.28% to 0.75%

It is noted that NPPD has previously supplied two well water analyses that indicate that well water chloride levels are in the range of 30 ppm. However, since the database is still limited, cases based on 100 ppm well water chloride are evaluated for conservatism.

In addition to the overall FGD mass balance model, S&L utilizes a separate mass balance model to estimate the quality of the bleed stream. Based on a 30,000 ppm chloride limit in the absorber and typical concentrations of metals in the range of PRB fuels under consideration, the estimated bleed stream quality before and after treatment for this chloride concentration level would be as follows:

Table 1 – Estimated Bleed Stream Quality (30,000 ppm Absorber Chloride)

	Total Concentration	Dissolved	Dissolved
	in Raw Wastewater	Concentration in Raw	Concentration Post
	(mg/l)	Wastewater (mg/l)	Treatment (mg/l)
PARAMETERS			
General			
Calcium (Ca)	156334	26061	26061
Magnesium (Mg)	39874	662	662
Sodium (Na)	4738	4738	4738
Potassium (K)	1922	1922	1922
Ammonia (NH_3)	N/A	N/A	N/A
Alkalinity (CaCO3)	50	50	50
Chloride (Cl)	29424	29424	29424
Sulfate (SO4)	352202	4000	4000
Fluoride (F)	10537	10537	10537
Nitrate (NO_3)	8638	8638	8638
Phosphate (PO4)	56.3	56.3	56.3
Silica (SiO2)	12967	250	250
pH	4.0 - 6.0	4.0 - 6.0	6.0 - 9.0
TDS	88218	88218	88218
TSS	2.5%	N/A	15
Metals			
Aluminum	5572	0.010	0.010
Antimony	42.7	42.7	42.7
Arsenic	18.56	18.56	0.1*
Barium	150.1	0.15	0.15
Beryllium	4.37	4.37	0.1*
Boron	11.69	11.69	11.69
Cadmium	8.59	8.59	0.01*
Chromium (total)	155.6	155.6	0.1*
Cobalt	0.883	0.883	0.883
Copper	619	619	0.1*
Iron	5556	0.100	0.100
Lead	62.99	62.99	0.1*

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	Total Concentration in Raw Wastewater (mg/l)	Dissolved Concentration in Raw Wastewater (mg/l)	Dissolved Concentration Post Treatment (mg/l)
Lithium	N/A	N/A	N/A
Manganese	290	290	290
Mercury (Inorganic)	11.917	11.917	0.005*
Mercury (Organic)	N/A	N/A	N/A
Molybdenum	N/A	N/A	N/A
Nickel	88.3	88.3	0.05*
Selenium	112.8	112.8	2*
Silver	8.55	8.55	0.01*
Strontium	165.4	165.4	2*
Thallium	8.55	8.55	0.25*
Tin	8.09	8.09	8
Titanium	131.0	131.0	131.0
Zinc	128.9	128.9	0.02*

Notes: * Indicates typical quality that wastewater treatment system vendors are willing to guarantee

It is noted that the bleed stream is a highly saline solution that is expected to have a freezing temperature in the range of 20 to 30°F based on the predominance of calcium chloride with lesser amounts of other magnesium and sodium based salts.

III. Treatment and Disposal Options

A. Option 1 – Zero Bleed Stream

Since there is no bleed stream, this option does not require evaluation of any disposal, reuse or treatment options.

B. Option 2 (1 gpm bleed per unit, 2 gpm total) - Recycle to Damp Fly Ash Unloading

B1. General Considerations

The station operates a damp fly ash unloading system with two rotary pan mixers that blend ash and process wastewater to produce a landfillable product that is trucked to the site's fly ash disposal pit. The FGD bleed would replace the process wastewater that is currently used in the wetting process.

According to NPPD, this is a batch process in which 9600 lb of ash are blended with 80 gallons of wastewater. Five batches of the landfillable product can be loaded into one semi-truck and there are typically 30 semi loads per day. This equates to 12,000 gallons per day of wastewater or 8.3 gpm on a continuous average basis.

The amount of available bleed based on Option 2 appears to be well below the needs of the damp unloading system. However, NPPD has indicated that the damp unloading system will not be operated continuously even if a decision is made to no longer sell the fly ash for commercial uses. Therefore, the FGD bleed to the damp unloading system will require interim storage. NPPD has requested that refurbishing the two hydrobins be considered for this purpose since they are no longer used. For redundancy, NPPD would prefer to refurbish both hydrobins; otherwise it would not be possible to inspect a hydrobin unless some other means of temporarily storing the waste water was provided. However, since each is large enough to provide approximately 165,000 gallons, representing two months of storage capacity, only a portion of each hydrobin would need to be refurbished to provide approximately seven days of storage per hydrobin. The refurbishment would essentially consist of providing an internal coating that is compatible with the FGD bleed stream.

An additional consideration for the use of the FGD bleed for the batch water to the fly ash damp unloaders is that the rotary pan mixers are constructed of mild steel. Although some sections of each mixer already have a rubber lining, the underlying mild steel may still need to be coated or replaced to withstand the corrosive effects of the saline bleed stream. Even though some good quality process wastewater may still need to be blended with the FGD bleed to meet the needs of the damp unloading system, the evaluation is conservatively based on the bleed stream providing the majority of the water requirements.

The overall conceptual design would be based on a small buffer tank in the FGD area collecting the bleed stream, which would then be pumped directly to one of the hydrobins. The bleed stream would be pumped from the hydrobins directly into the existing damp unloader water supply lines when the units are in operation.

In addition to the hydrobin refurbishment costs provided below, the bleed water delivery system for ash conditioning will require about 1,000 ft of small 1-1/2 inch insulated and heat traced line between the two FGD buildings and the storage tanks plus two 100% 10 gpm (approx) ash conditioning feed pumps and insulated and heat traced piping from the pumps to the pan mixers. The estimated installed cost allowance for the bleed water delivery system is $100,000.

Demolition costs associated with the hydrobin internal and external equipment that are no longer operational are not detailed in this analysis, but are assumed to be equivalent between the refurbishment options and minimal compared to the overall costs.

B2. Hydrobin Coating

The requirements for internal coating of the converted hydrobin have been evaluated by S&L. Before any further consideration is given to the hydrobin option, it is recommended that a condition assessment be performed for each hydrobin under consideration for use as an equalization tank. The condition assessment should include the following items as a minimum:

- Determine what materials were used for the hydrobin and associated components, especially the materials which will be exposed to the waste water.
- Inspect exterior surfaces of hydrobins for any evidence or indications of leaks.
- Determine extent of corrosion of the hydrobin internal surfaces and components.

  - Make note of the location, size, depth, and which hydrobin the crevice corrosion, pitting, or other areas of significant deterioration/wall thinning were found.
  - In areas where significant wall thinning is suspected, use ultrasonic (UT) test equipment to determine wall thickness in several locations in the area of wall thinning. Average these wall thickness measurements, and compare them to the original design thickness indicated on the relevant drawings. Document these results for further evaluation.
  - Adequate extent of corrosion analysis will likely require the interior surfaces of the hydrobins to be cleaned prior to inspection. All debris, corrosion products, scale, and other foreign materials/objects should be removed from the hydrobin floors and surfaces.
- Note the type and location of any equipment or other components present inside the hydrobins. Prior to coating application, all unnecessary components should be removed to minimize nooks, corners, and edges to help ensure proper coating application.

The option to prepare and coat the existing mild steel hydrobins for use as equalization tanks does carry some inherent risks. The expected waste water chemistry, temperature ranges, and acidic pH would be considered an aggressive corrosion environment for mild steels. Bare mild steel exposed to this environment would be expected to experience severe general corrosion and even greater corrosion at crevices. Any holiday, defect, or failure in an applied coating system occurring below the water line that exposes the base metal will lead to significant and accelerated preferential corrosion at that location. This deterioration also has the potential to cause failure of the surrounding, previously sound, coatings leading to propagation of the problem. This makes coating selection, surface preparation, and coating application critical to the successful repurposing of the hydrobins. The use of more traditional materials in a new equalization tank(s) (e.g. FRP, HDPE, etc.]) would eliminate these corrosion issues.

Additionally, based on Sargent & Lundy (S&L) experience, there are few applicators capable of applying successful coatings in situations of aggressive corrosion environment coupled with poor existing surface conditions. These risks should be carefully considered before the decision to repurpose the hydrobins is made.

In general terms, S&L recommends an abrasion resistant vinyl ester coating system (such as Carboline's Plasite 4110 or equivalent) or a high solids epoxy coating system (such as Duromar's HPL-4310, Jones-Blair's Chem-O-Gard I, or equivalent) for the expected hydrobin operating conditions.

The total installed cost for applying any of the above coatings is in the range of $20 to $30 per square foot or $70,000 to $100,000 for a complete tank or vessel similar in size to the Gerald Gentleman hydrobins. However, each hydrobin is large enough to store 165,000 gallons of bleed, so it would not be necessary to coat the entire hydrobin interior surface. Coating sufficient interior surface to provide seven (7) days of storage at 2 gpm plus freeboard would be in the range of $40,000 to $60,000. The cost would be approximately double to coat two hydrobins for redundancy. Should NPPD decide to coat the hydrobins, S&L would provide specific recommendations for the surface preparation and actual application of the coating.

As an alternative to spray-on type coatings, S&L also obtained a quotation from Stebbins Engineering for tile lining of the hydrobins (Attachment B). Stebbins proposed their SEMPLATE/SCI tile lining, similar to the product that has been successfully used in wet FGD systems. Compared with spray-on type coatings, the Stebbins tile is a more rugged and durable product that is less likely to develop defects from inadequate surface preparation, installation of the tiles, themselves or contact with the FGD bleed stream. However, the Stebbins tile is also considerably more expensive. Stebbins would provide and install the tile at a cost of $415,000 per hydrobin, for lining of the complete vessel. The cost would be approximately double if NPPD elected to install tile in both hydrobins for redundancy. Lining sufficient interior surface to provide seven (7) days of storage at 2 gpm plus freeboard would cost approximately $250,000 per hydrobin.

B3. New Storage Tanks

Due to the inherent risks associated with applying a spray-on type coating to the interior of the hydrobins and the high cost associated with a more rugged product such as the Stebbins tile, new FRP storage tanks were also considered. Because there is limited free space in the vicinity of the damp unloaders, S&L believes that the best option would be to install these new storage tanks within the hydrobins, themselves. S&L also believes that the tanks should be supplied as shop fabricated tanks, as opposed to field fabricated tanks to reduce overall cost.

A sketch of the proposed arrangement is provided in Attachment C. Two new FRP storage tanks would be installed in one hydrobin. Each storage tank would have a capacity of approximately 20,000 gallons and would have dimensions of 12 ft diameter x 24 ft H. Each tank would provide approximately 7 days of storage based on a 2 gpm bleed rate for both units. The total cost to furnish and install the two tanks is approximately $72,000. In order to accommodate the new storage tanks, the hydrobin would need to be modified to include a support structure for the tanks and grated floor for personnel access. The estimated cost for these modifications is $134,000, making the total cost for the new tank option approximately $206,000.

If additional storage capacity were required by NPPD, then a second hydrobin would need to be modified. It would be recommended to duplicate the modifications to the first hydrobin; therefore, doubling the total storage capacity (28 days of storage) and doubling the cost ($412,000). It is not recommended to make each FRP tank larger for several reasons: First, shop fabricated tanks are limited in diameter and height due to shipping restrictions. The tank size selected is close to the largest size available before the supplier would need to ship the tank in multiple sections. Second, tanks much taller than 24 ft would impose additional wind load on the hydrobin support structure. This could possibly require additional reinforcement and add more cost for not much gain in capacity. Lastly, larger diameter tanks up to 14 ft could possibly fit within the hydrobin, however, access around the tanks would be limited.

B4. Damp Unloader Refurbishment or Replacement

S&L briefly reviewed the drawings and O&M manual for the damp unloading system and contacted the original equipment supplier, Dustmaster for additional information. Dustmaster has maintained all of the pertinent information for the Gerald Gentleman Station and has assisted other customers who are interested in supplying an alternate water source that has a more corrosive or abrasive nature. Dustmaster provided two alternate quotes (Attachment D based on either refurbishing or replacing the existing damp unloading units. According to Dustmaster, refurbishment of the existing units would be extensive because the rubber linings are only intended to provide some abrasion resistance to PRB ash and are not intended to provide a tight seal to protect the underlying metal. As indicated in the attached quote, the equipment cost for refurbishing each unit would be $118,000, which is approximately half the cost of $224,000 to provide a completely new unit. The lead times for refurbishing and replacing the damp unloaders are in the range of 6-8 weeks and 12-14 weeks,, respectively.

C. Option 3 (6 gpm bleed per unit, 12 gpm total) - Zero Liquid Discharge (ZLD)

Based on the design bleed rate of 12 gpm, the design capacity of the ZLD system would be in the range of 15 gpm. This would allow for one week of emergency inventory that was accumulated when the ZLD was out of service to be treated within one month. S&L was able to obtain a budgetary quote for a similarly sized (i.e. 10 gpm) ZLD system (Attachment E). Included in the quote is a process flow diagram for the ZLD system. After lime/soda softening for removal of hardness, the pretreated feedwater is then preheated and enters a forced circulation crystallizer that would be mechanically driven with an integral vapor compressor. A packaged boiler is used to provide a source of steam to the crystallizer during startup only. An external source of steam from the plant is not required either during startup or normal operation. After the crystallizer, the slurry would be sent to a belt filter press for final dewatering. The belt filter press produces a solid waste product that typically contains < 10% moisture and is generally classified as non-hazardous.

The vapors from the crystallizer are condensed against the incoming feedwater in the preheater. The vapors constitute a high purity distillate containing < 10 ppm of dissolved solids that can be returned to the FGD system or used elsewhere in the power plant. Typically, at least 95% of the incoming wastewater can be recovered as distillate.

The ZLD system would have an overall footprint of 50 ft W x 80 ft L x 37 ft H and would be located on the east side of the dewatering building as shown in the attached general arrangement drawing (Attachment F)

Based on cost considerations, it is not common to install redundant ZLD systems. It is more common to install an emergency storage pond or tank with one week of storage. Storage in excess of two weeks is not recommended because of the time that would be needed to treat the large wastewater inventory.

It is noted that the turndown of the ZLD system is in the range of 50% to 60% and that the system could be operated at throughputs as low as 4 gpm, if required. However, it is generally recommended that the system be operated at its' rated capacity and be placed on hot standby when not in use. It is also noted that the forced circulation crystallizer is generally the most economical design for small (e.g. 15 gpm) applications and that falling film evaporators, although widely used, are generally reserved for larger (e.g. 50 gpm or greater) applications.

It is also noted that recycle of the FGD bleed stream to the damp fly ash unloading system could be implemented in addition to a new, single unit ZLD system. There would be little benefit in recycling the bleed stream to the damp unloading system if redundant ZLD systems were provided. With a single unit ZLD system, the equipment would still be sized for a nominal 15 gpm capacity in the event that the damp unloading system is out of service. It is not expected that a slightly smaller ZLD system in the range of 10 to 15 gpm would have a significant impact on the cost of the system. Also, an entire hydrobin would be lined or coated to provide the maximum storage capacity. Using the majority of the FGD bleed stream in the damp unloading system would require that the ZLD system be operated at a lower capacity or that the system be maintained in hot standby or taken out of service. However, the damp unloading system could provide an extra level of redundancy in the event that the ZLD system was out of service for extensive maintenance.

The equipment price for the 10 gpm system based on the Aquatech quotation and subsequent correspondence that included the cost of interconnecting piping is in the range of $5,300,000. It is noted that the cost of the recommended 15 gpm system would be in the range of $6,500,000 to $7,000,000. Although the ZLD system has a very small capacity, the cost is substantial due to the need for Hastelloy materials of construction, which are needed with 30,000 ppm of chloride in the bleed stream. Order of magnitude total installed costs for this 15 gpm ZLD system, which is largely preassembled, but requires a small building are in the range of $20,000,000 to $25,000,000. This cost would include modifications to the damp unloading system and an internal coating of one hydrobin to enable the bleed stream to be used for fly ash conditioning in the event of a system outage. The equipment price, total installed cost and footprint would be approximately doubled if NPPD elected to install redundant ZLD systems. Annual operating costs would be in the range of $250,000. The system would require 100 kW of power (included in the O&M cost estimate).

D. Other Options

As requested by NPPD, S&L also evaluated another option based on trucking the FGD bleed stream to the ash and gypsum disposal areas and spraying the wastewater onto each area for dust suppression. This would eliminate the modifications associated with using the bleed stream in the damp fly ash unloading system. From a regulatory perspective, S&L determined that the FGD bleed stream is a hazardous material and therefore would be prohibited from being trucked to the waste disposal areas unless treatment were provided to render the bleed stream non-hazardous.

From a regulatory perspective, this option depends on whether the FGD bleed stream (used for dust suppression) would be classified as a solid waste under 40 CFR 261.2. In general, a "solid waste" is any discarded material that is not excluded from regulation by a variance or a non-waste determination made under §§260.30 and 260.34. A "discarded material" is any material which is abandoned, recycled, or considered inherently waste-like. Specifically, materials are solid wastes if they are recycled by being applied to or placed on the land in a manner that constitutes disposal. (§260.2(c)(1). However, materials that are used or reused as an effective substitute for a commercial product are not considered to be a solid waste. (§260.2(e)(1)(ii)).

Although it could be argued that the FGD bleed stream could be used as an effective substitute for a commercial dust suppressant, there are several stipulations to this exclusion that must be taken into consideration. For example, materials used in a manner constituting disposal are solid wastes even if the recycling involves use, resuse, or return to the original process. (§260.2(e)(2). Furthermore, to be considered an effective substitute for a commercial product, the FGD bleed stream could not contain significant concentrations of hazardous constituents found in Appendix VIII of Part 261 that are not found in the analogous dust suppressant products. Based on the raw wastewater characteristics listed in Table 1, it appears unlikely that the FGD bleed stream would meet this criterion.

Based on a review of EPA policy memos, it appears that using the FGD bleed stream as a dust suppressant would be classified as use or reuse in a manner constituting disposal. Thus, the bleed stream would be classified as a solid waste, and would not be considered an effective substitute for a commercial product. Based on the metal concentrations of the raw wastewater stream in Table 1, several constituents (including arsenic, barium, cadmium, chromium, lead, selenium, and silver).exceed their respective TCLP concentrations in 40 CFR 261.24. Thus, the FGD bleed stream would be classified as a characteristic hazardous waste. Based on this interpretation of the federal solid waste regulations (which should be reviewed by NPPD's legal council) using the FGD bleed stream as a dust suppressant does not appear to be a viable option.

IV. Summary and Recommendations

Three options have been evaluated for the disposal, reuse and/or treatment of the FGD bleed stream. The options are defined based on the sulfur and chlorine contents of the fuel, which influence the bleed rate.

Option 1 (zero bleed rate): With 50 ppm of chlorine in the fuel and 30 ppm of chloride in the makeup water, the amount of water leaving with the gypsum is sufficient to maintain the chloride balance as long as the fuel sulfur is > 0.37%. With 100 ppm of chlorine in the fuel and 100 ppm of chloride in the makeup water, no bleed is required as long as the fuel sulfur is > 0.9%.

Option 2 (2 gpm bleed rate): The amount of bleed is small enough to allow disposal by reuse within the damp fly ash unloading system. However, because the damp unloading system is not in continuous use, storage of the bleed stream is necessary. As requested by NPPD, S&L investigated using the existing hydrobins for storage and determined that one hydrobin can provide approximately two months of storage. For redundancy, NPPD would prefer to refurbish both hydrobins; otherwise it would not be possible to inspect a hydrobin unless some other means of temporarily storing the plant was provided. However, since each is large enough to provide two months of storage capacity only a portion of each hydrobin would need to be refurbished. Each hydrobin may need to be extensively refurbished in order to apply an internal coating and there would still be inherent risks associated with maintaining the coating integrity. Therefore, the use of Stebbins tile, which is a more rugged and durable product, was also investigated. Although the Stebbins tile is a more rugged and durable product compared to a spray-on coating, it is also considerably more expensive. S&L believes that the best alternative is new FRP storage tanks that would be installed in the existing hydrobins due to limited free space near the damp unloaders. With regard to the damp unloaders, themselves, discussions with the equipment supplier (Dustmaster) indicate that the existing unloaders will either need to be extensively refurbished to handle the highly corrosive bleed stream or new unloaders would need to be purchased. Costs for both options were provided by Dustmaster.

Option 3 (12 gpm bleed rate): The ZLD system would utilize a 15 gpm forced circulation crystallizer and a belt filter press to dewater the crystallizer slurry. The bleed stream would be pretreated by lime/soda softening for the removal of hardness prior to the crystallizer. A single ZLD system would include modifications to the damp unloading system to allow this system to provide emergency backup when the ZLD system is out of service. It is noted that the installed cost would be approximately double should NPPD elect to install two ZLD systems for redundancy.

There is no cost associated with Option 1, which has a zero bleed rate. Costs for Options 2 and 3 are summarized below for the various options:

Option 2	
A. Storage	
1. internal coating of two hydrobins or	$80,000 - $120,000
2. Stebbins lining of two hydrobins or	$500,000
3. two FRP tanks in one hydrobin	$206,000
B. Interconnecting Piping	$100,000
C. Damp Unloading Modifications	
1. refurbishment of two damp unloaders or	$236,000
2. two new damp unloaders	$448,000
Total Installed Cost for Option 2	$416,000 - $1,048,000
Option 3	
A. Single ZLD System	
1. equipment cost	$6,500,000 - $7,000,000
2. total installed cost (includes damp unloading system and hydrobin modifications)	$20,000,000 - $25,000,000
B. Redundant ZLD System	
1. equipment cost	$13,000,000 - $14,000,000
2. total installed cost (includes damp unloading system and hydrobin modifications)	$40,000,000 - $50,000,000

As stated above, S&L also evaluated a fourth option based on trucking the FGD bleed stream to the fly ash and gypsum disposal areas. It was concluded that the bleed stream would be classified as a hazardous waste and therefore could not be used in this manner unless treatment were provided to render the bleed stream non-hazardous.

Based on the available fuel data and the FGD mass balances, S&L believes that a bleed stream will not normally be required and would be in the range of 12 gpm under a worst case scenario. Although the costs for implementing Option 2 are modest compared with the cost of a ZLD system, S&L recommends that any decisions regarding disposal, reuse and/or treatment of the bleed stream be deferred until NPPD performs additional sampling to better define fuel chloride levels. The lead time for refurbishing hydrobins and refurbishing or replacing the damp unloaders is short compared with the overall lead time for the wet FGD project and should not impact the overall project schedule.

ATTACHMENT A
FGD MASS BALANCE SUMMARIES

NPPD
Gerald Gentleman Station

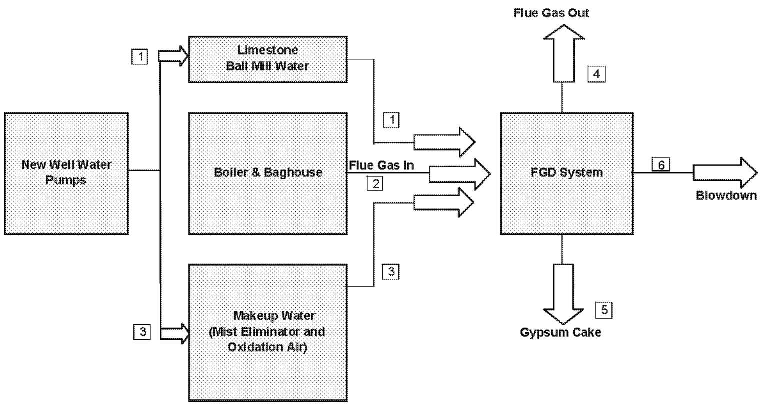
FGD Process Water Balance

Project No. 12681-006
September 12, 2011

Description:

The following water balance shows the various water requirements for the wet FGD process.
These flows are based on the design mass balance that was sent to NPPD on July 19, 2011. These demand flows would be required on a continuous basis.
From here, S&L will integrate this process specific water balance into the existing site plant water balance. Any waste streams generated will be also be integrated into the plant water balance. It should be noted that there will be intermittent water requirements for activities such as washdown, flushing and quench. Since these flows are intermittent, they would be built into the sizing of the FGD makeup water tanks and pumps and not necessarily part of the FGD process water requirements.

Flow Diagram:



Water Streams for Design Fuel:
Design Inputs: 0.01% Fuel Cl, 0.75% Fuel S, 100 ppm Cl in Makeup Water

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	47,755	95	50,038	100
2	566,752	1,132	597,176	1,193
3	469,245	938	471,819	943
4	1,073,069	2,144	1,107,905	2,214
5	10,038	20	10,518	21
6	646	1	610	1
TOTAL WATER IN	1,083,752	2,165	1,119,033	2,236
TOTAL WATER OUT	1,083,752	2,165	1,119,033	2,236

Predicted Water Streams:

1a. Inputs: 0.01% Fuel Cl, 0.28% Fuel S, 100 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	18,181	36	19,050	38
2	567,657	1,134	598,120	1,195
3	491,654	982	495,444	990
4	1,070,814	2,140	1,105,682	2,209
5	3,756	8	3,936	8
6	2,922	6	2,996	6
TOTAL WATER IN	1,077,492	2,153	1,112,614	2,223
TOTAL WATER OUT	1,077,492	2,153	1,112,614	2,223

1b. Inputs: 0.005% Fuel Cl, 0.28% Fuel S, 30 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	18,039	36	18,901	38
2	567,668	1,134	598,131	1,195
3	489,298	978	493,021	985
4	1,070,817	2,140	1,105,684	2,209
5	3,756	8	3,935	8
6	433	1	434	1
TOTAL WATER IN	1,075,005	2,148	1,110,053	2,218
TOTAL WATER OUT	1,075,006	2,148	1,110,053	2,218

2a. Inputs: 0.01% Fuel Cl, 0.75% Fuel S, 100 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	47,755	95	50,038	100
2	566,752	1,132	597,176	1,193
3	469,245	938	471,819	943
4	1,073,069	2,144	1,107,905	2,214
5	10,038	20	10,518	21
6	646	1	610	1
TOTAL WATER IN	1,083,752	2,165	1,119,033	2,236
TOTAL WATER OUT	1,083,752	2,165	1,119,033	2,236

2b. Inputs: 0.005% Fuel Cl, 0.75% Fuel S, 30 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	47,613	95	49,889	100
2	566,763	1,132	597,187	1,193
3	466,875	933	469,383	938
4	1,073,071	2,144	1,107,908	2,214
5	10,038	20	10,517	21
6	(1,857)	(4)	(1,966)	(4)
TOTAL WATER IN	1,081,251	2,160	1,116,459	2,231
TOTAL WATER OUT	1,081,252	2,160	1,116,459	2,231

3a. Inputs: 0.01% Fuel Cl, 1.0% Fuel S, 100 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	63,435	127	66,467	133
2	566,272	1,131	596,676	1,192
3	457,360	914	459,291	918
4	1,074,261	2,147	1,109,081	2,216
5	13,368	27	14,008	28
6	(562)	(1)	(655)	(1)
TOTAL WATER IN	1,087,067	2,172	1,122,434	2,243
TOTAL WATER OUT	1,087,067	2,172	1,122,434	2,243

3b. Inputs: 0.005% Fuel Cl, 1.0% Fuel S, 30 ppm Cl in Makeup Water, 30,000 ppm Cl

	GGS Unit 1		GGS Unit 2	
Stream	(lb/hr)	(gpm)	(lb/hr)	(gpm)
1	63,293	126	66,319	133
2	566,283	1,132	596,687	1,192
3	454,984	909	456,846	913
4	1,074,264	2,147	1,109,083	2,216
5	13,368	27	14,007	28
6	(3,072)	(6)	(3,238)	(6)
TOTAL WATER IN	1,084,560	2,167	1,119,852	2,238
TOTAL WATER OUT	1,084,560	2,167	1,119,852	2,238

Predicted Absorber Chloride Level (ppm) Zero Liqid Blowdown Discharge Point:
1a. Inputs: 0.01% Fuel Cl, 0.28% Fuel S, 100 ppm Cl in Makeup Water
The predicted absorber equilibrium chloride level for zero blowdown is approximately 95,000 ppm Cl.

1b. Inputs: 0.005% Fuel Cl, 0.28% Fuel S, 30 ppm Cl in Makeup Water
The predicted absorber equilibrium chloride level for zero blowdown is approximately 40,000 ppm Cl.

2a. Inputs: 0.01% Fuel Cl, 0.75% Fuel S, 100 ppm Cl in Makeup Water
The predicted absorber equilibrium chloride level for zero blowdown is approximately 35,000 ppm Cl.

2b. Inputs: 0.005% Fuel Cl, 0.75% Fuel S, 30 ppm Cl in Makeup Water
This scenario is already at a zero blowdown discharge point.

3a. Inputs: 0.01% Fuel Cl, 1.0% Fuel S, 100 ppm Cl in Makeup Water
This scenario is already at a zero blowdown discharge point.

3b. Inputs: 0.005% Fuel Cl, 1.0% Fuel S, 30 ppm Cl in Makeup Water
This scenario is already at a zero blowdown discharge point.

ATTACHMENT B
STEBBINS QUOTATION FOR TILE LINING OF HYDROBINS

THE
STEBBINS ENGINEERING AND MANUFACTURING COMPANY
363 Eastern Boulevard
Watertown, New YorkUSA 13601-3140
www.StebbinsEng.com
Telephone: (315) 782-3000
Telecopier: (315) 782-0481
E-Mail: info@StebbinsEng.com

October 5, 2011

CONFIDENTIAL

Sargent & Lundy LLC
55 East Monroe Street
Chicago, IL60603

Attention: Mr. Michael D. Rosen email: michael.d.rosen@sargentlundy.com

Reference: BUDGET PROPOSAL
Lining Installation of Four (4) Existing Hydrobins

Nebraska Public Power District
Gerald Gentleman Station
Sutherland, NE

STEBBINS Ref. 14-280-787-0

Gentlemen:

We offer this Budget Proposalin response to your request to provide budget pricing for the turnkey supply of four (4) SEMPLATE/SCI linings in existing elevatedHydrobins at Gerald Gentleman Station in Sutherland, NE.

As you are aware,the STEBBINS SEMPLATE liningscan handle a wide range of chloride exposure well over the anticipated 30,000ppm for this application.

This Proposalis based on theinformation in Sargent & Lundy's inquiry and the assumptions that the vessels are in good condition, devoid of internals,and that all vessel modification will be made by Sargent & Lundy or others. Also, a S.G. of 1.05was assumed to develop the net additional load on the vessel supports. We estimate +/-30 kips per vessel additional weight due to the STEBBINS lining installation.

STEBBINS CONFIDENTIAL PROPOSAL

BUDGET PROPOSAL
Nebraska Public Power District
Gerald Gentleman Station
Sutherland, NE
Lining Installation of Four (4) Existing Hydrobins
STEBBINS Ref. 14-280-787-0

BASIS FOR LINING DESIGN

Reference Drawing: Per Sargent & Lundy Inquiry

Dimensions: 47.25'OAH (including 23.5' cone) x 30' IDs

Process Conditions:

Operating Temp:	100-120°F
pH:	4.0 to 6.0
Chlorides:	30,000 ppm
SG:	1.05 assumed

SCOPE OF WORK

STEBBINS turnkey installation of four (4) SEMPLATE/SCI linings in existing elevatedHydrobins at Gerald Gentleman Station, Sutherland, NE. Scope of supply includes design, materials, equipment, scaffolding, supervision, and labor.

WORK PROVIDED BY OTHERS

Existing foundation and existing steel tank provided.

Sargent & Lundy or agent to perform all vessel modifications and provide access to all four (4) vessels devoid of internals.

Worksite access for material handling at grade for lifting to elevation.

WORK PROVIDED BY STEBBINS

Design, supply, and erect all scaffolding for external and internal access.

Design, supply, and install masonry and membrane lining systems to the interior of all four (4) vessels.

Installation will be completed on a consecutive basis of two (2) vessels simultaneously. Installation will be completed in 2-2½ months for each set of two (2) vessels for a total of 4-5 months.

STEBBINS CONFIDENTIAL PROPOSAL

BUDGET PROPOSAL
Nebraska Public Power District
Gerald Gentleman Station
Sutherland, NE
Lining Installation of Four (4) Existing Hydrobins
STEBBINS Ref. 14-280-787-0

2011BUDGET PRICE

2011BUDGET PRICE(-10/+15%)based on STEBBINS' turnkey supply of four (4) SEMPLATE/SCI liningsin existing Hydrobinsat the Gerald Gentleman Station, Sutherland, NE site including design, materials, equipment, scaffolding, supervision and labor is
.... **US$305,000/vessel**

2011BUDGET PRICE ADD if crane is required for material handling
.... **US$+35,000/vessel**

2011 BUDGET PRICE ADD if installation is completed on a stand-alone basis, independent of pending scrubber project at NPPD
.... **US$+75,000/vessel**

*****

In the meantime, please do not hesitate to contact ***Robert Aliasso or the writer with any questions or requests for additional information.*** STEBBINS will proceed with a firm price quote with additional details provided by Sargent & Lundy once a specific course of action has been decided upon.

Very truly yours,

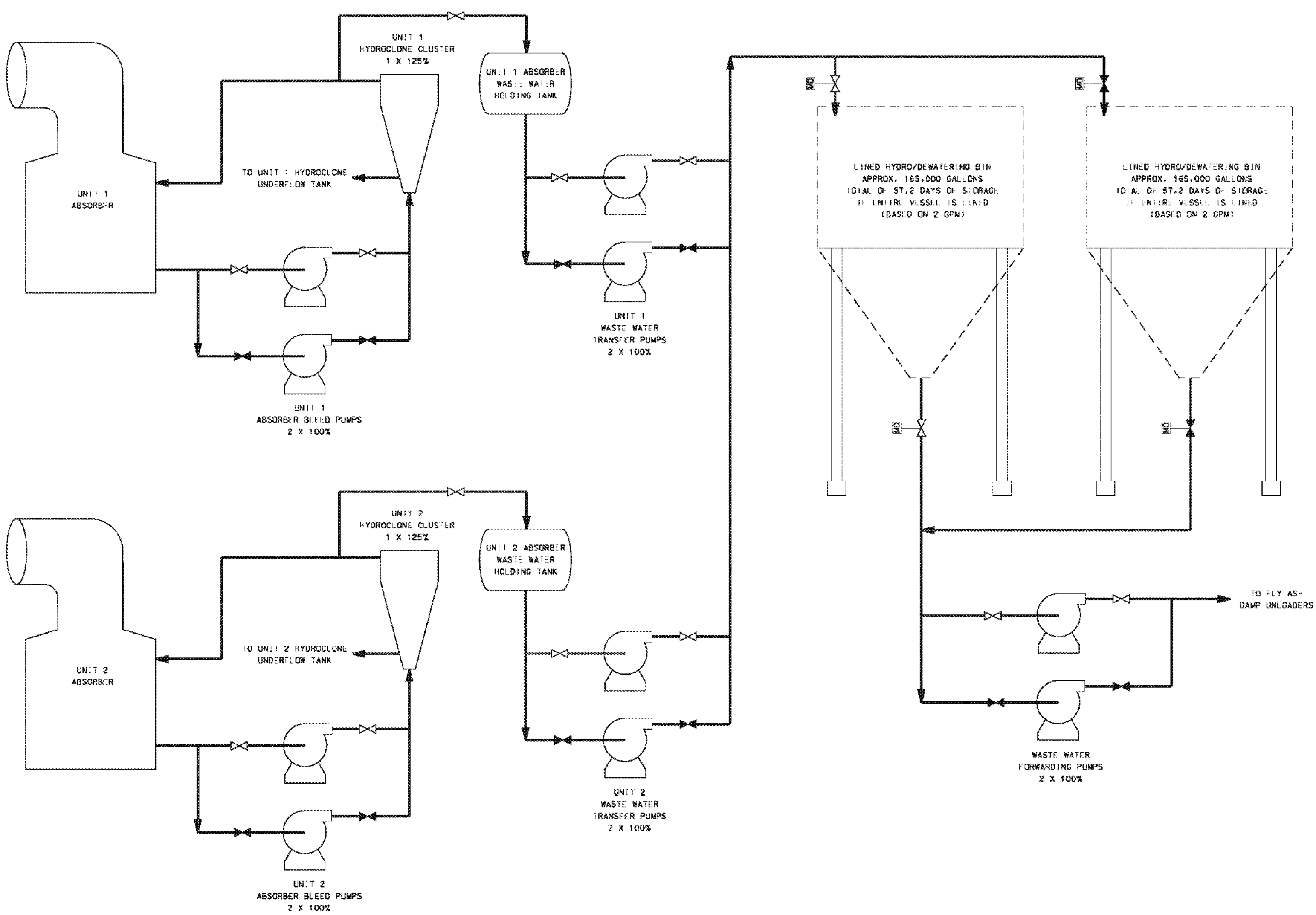
THE STEBBINS ENGINEERING
AND MANUFACTURING COMPANY

Mallyssa Ditch – electronically signed on behalf of STEBBINS

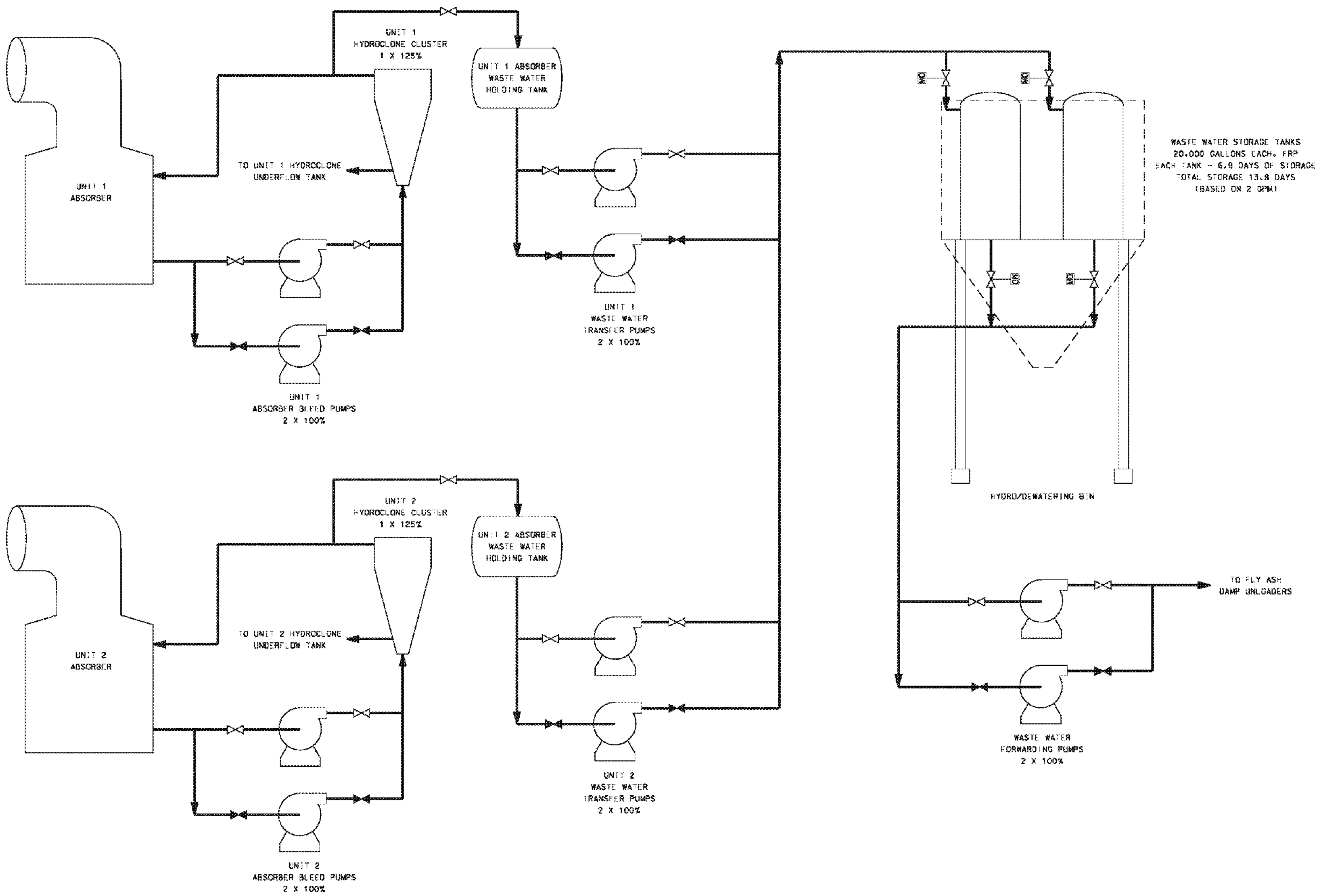
Mallyssa Ditch, Sales Engineer
STEBBINS Lining Division
maditch@stebbinseng.com
+1 (315) 661-2929

ATTACHMENT C
FLOW DIAGRAMS FOR BLEED STREAM OPTIONS

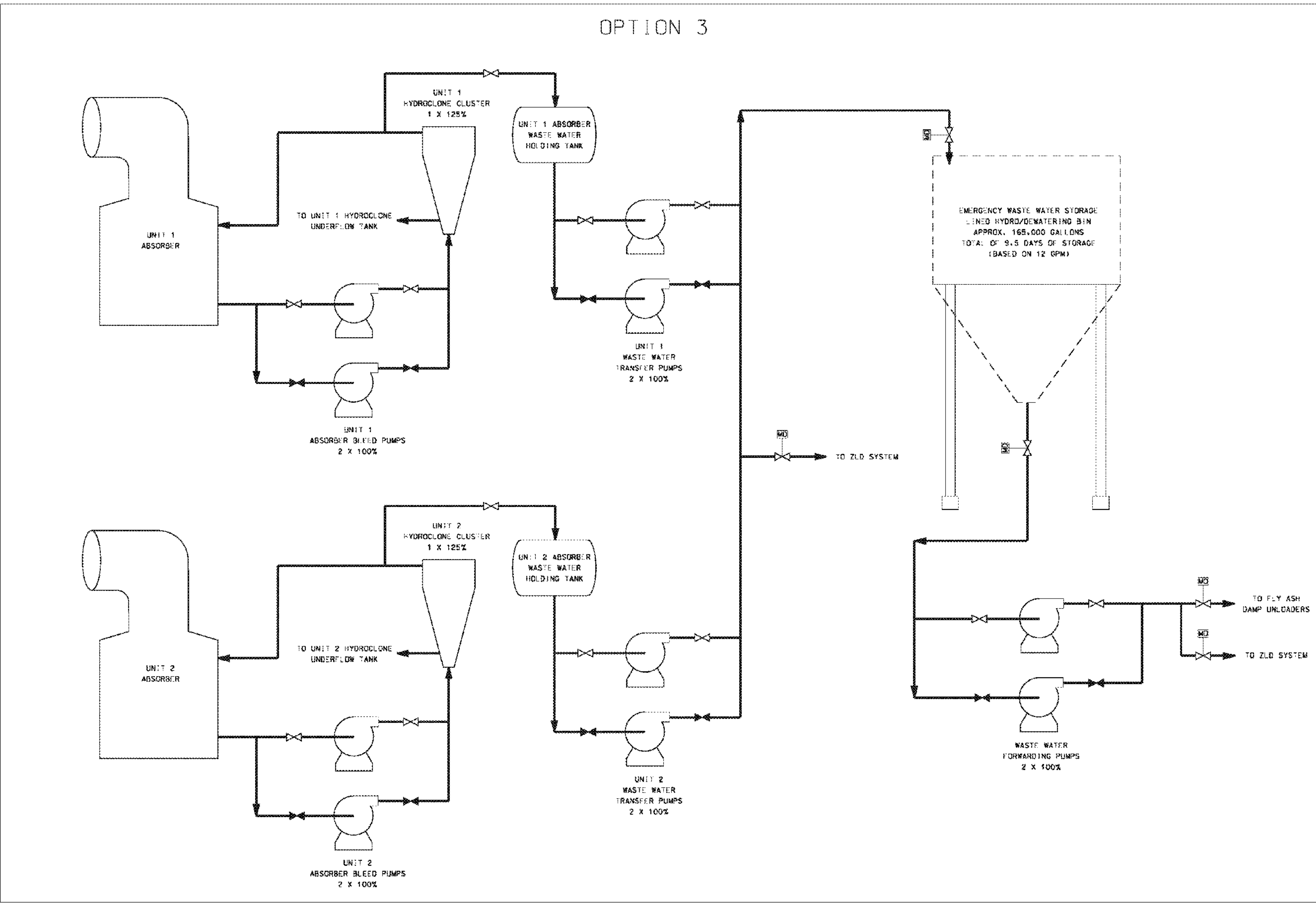
OPTION 2 – HYDROBIN COATING



OPTION 2 – NEW STORAGE TANKS



Question 1


OPTION 3
UNIT 1 HYDROCLONE CLUSTER 1 X 125%
UNIT 1 ABSORBER WASTE WATER HOLDING TANK
UNIT 1 ABSORBER
TO UNIT 1 HYDROCLONE UNDERFLOW TANK
UNIT 1 WASTE WATER TRANSFER PUMPS 2 X 100%
UNIT 1 ABSORBER BLEED PUMPS 2 X 100%
EMERGENCY WASTE WATER STORAGE
LINED HYDRO/DEWATERING BIN
APPROX. 165,000 GALLONS
TOTAL OF 9.5 DAYS OF STORAGE
(BASED ON 12 GPM)
MO
TO ZLD SYSTEM
UNIT 2 HYDROCLONE CLUSTER 1 X 125%
UNIT 2 ABSORBER WASTE WATER HOLDING TANK
UNIT 2 ABSORBER
TO UNIT 2 HYDROCLONE UNDERFLOW TANK
UNIT 2 WASTE WATER TRANSFER PUMPS 2 X 100%
UNIT 2 ABSORBER BLEED PUMPS 2 X 100%
TO FLY ASH DAMP UNLOADERS
TO ZLD SYSTEM
WASTE WATER FORWARDING PUMPS 2 X 100%

ATTACHMENT D
DUSTMASTER QUOTATIONS FOR NEW AND REFURBISHED DAMP FLY ASH UNLOADERS

DUSTMASTER® ENVIRO SYSTEMS Division of Mixer Systems, Inc.
190 Simmons Avenue • P.O. Box 10 • Pewaukee, WI 53072-0010 • Ph (262) 691-3100 • Fax (262) 691-3184 • www.dustmaster.com

TO: Sargent & Lundy
55 East Monroe Street
Chicago, IL 60603-5780

QUOTATION #: DM0882-11

DATE: September 7, 2011

VALIDITY: 30 Days

TERMS: 25% Due with Order
50% Due at Approval Drawing
25% Due Before Final Shipment

APPROXIMATE DELIVERY AFTER RECEIPT OF ORDER AND FINAL APPROVAL DRAWINGS: 12-14 Weeks

CUSTOMER INQUIRY: Michael Rosen

APPROVAL DRAWINGS: 2-3 Weeks

200 TPH DustMASTER Series II System with Turbin Mixer Model 450
Including 150 HP electric motor, 200 tons/hr.*

*Capacity based on material being processed weighing 50 lbs. per cu. ft.

Standard Equipment Includes with Brine Water Processing:
(All motors are 460v, 3 ph, 60 Hz)

ITEM A

Mixer Module:

- Turbin mixer assembly – tank shell is 3/16" carbon steel-A36
- 150 HP TEFC motor with v-band belt drive
- Gyro-Drive gear reducer, mounted internally in mixer center tank well
- Discharge door, one (1) swivel floor segment, hydraulically operated with two (2) proximity type limit switches
- Hydraulic power pack assembly with 5 HP TEFC motor to operate discharge door cylinder
- Custom cover assembly with bi-fold doors, inspection hatch and magnetic non-contact safety limit switches, charging panel with inlet flange and vent pipe stub connection
- Mixing paddles, wall and well scrapers are from Cast Ni-hard
- Jog/clean-out station with emergency stop and warning horn mounted on mixer
- Zero Speed Switch – monitors speed of input drive sheave of mixer gear reducer

Batcher Module:

- Mixer mounted on load cell pedestal with three (3) floor mount load cells
- Summing box NEMA 4 enclosure mounted on mixer

Air Line System Module:

- Single Solenoid Valves for remote control of pneumatic system batching valves
- Filter, Regulator & Lubricator assembly including all hoses and clamps

Control Module:
- Programmable controller- Allen Bradley Compactlogix L32E
- Emergency manual controls
- Mounted in NEMA 4 enclosure
- Terminal block wired
- Color touch panel operator interface
- Field programmable watchdogs, timers & batch parameters
- Ethernet compatible

Support Module:
- Knife gate, hand wheel operated for silo isolation
- Rolling blade gate, pneumatically operated for material batching
- Connection chute with flex joint boot and clamping bars, mounted between rolling blade gate and mixer inlet flange
- Mixer discharge chute, floor mounted, approximately 11'-0" with 3'-0" flexible boot

ITEM B
Brine Water Package consisting of the following:
Mixer Tank Coating:
- Sandblast interior of mixing tank, rotating case and bottom of cover and line with special corrosion resistant coating
- Interior coating to be Ceilcote 242AR Flakline specifically designed for corrosive environments subject to surface wear
- Exterior to be standard MSI paint

Rubber Liners:
- 80 durometer rubber. The well and wall liners will be extended upward for maximum coverage.
- Caulk using chemical etching for rubber and two (2) part urethane system.

Brine and Process Water Header
- Custom FRP pipe/fabrications
- Teflon lined butterfly disc
- 4" globe valve replace with FRP/composite compound ball valve
- Magflow meter Teflon lined
- Custom stand to attach header
- Our standard stainless steel clamps and hose to connect header assembly to rotary union on the mixer
- Custom FRP pipe assembly to combine brine with water header

Rotary Water System:
- Special custom cast brass alloy with rotary union joint ceramic seal package
- Sandblast and line rotary union distribution box with corrosion resistant coating and also line

combination nipples for hose
- Custom FRP water manifold assembly with drop tubes {three (3) assemblies per mixer}
- Our standard hose and stainless steel clamps to connect rotary union distribution box and three (3) rotating water headers

TOTAL PRICE F.O.B. FACTORY, PEWAUKEE, WI (NOT INSTALLED)..................$224,520

OPTIONS

ITEM C
Remote Truck Driver Station – Not Included In Pricing: $4,105
- Remote load size switch "A-B-C" (field programmable)
- Remote batch start/stop
- Emergency stop
- Trouble light
- In-process light
- Process complete

ITEM D
Mixer Tank Temperature Sensor – Not Included In Pricing: . . . .
$395

ITEM E
Mixer Transmission Temperature Sensor – Not Included In Pricing: $395

ITEM F
Equipment Start-up:
Field Service Technician will provide equipment start-up assistance during the final start-up of the plant. The Field Technician would arrive after all the equipment is located, load cells calibrated, wired and motors have been bumped to make sure they are running in the right direction.

His Duties Will Include:
- Final troubleshooting of equipment operation.
- Supervise mechanics, electricians and operators in adjustments to be made to make the equipment run properly.
- Oversee the control set-up and scale(s) and level probe(s) calibrations.
- Explain adjusting procedures and maintenance of all equipment.
- Train the personnel in the proper operation and adjustments of the control.
- Teach the personnel in operating the control in the manual and automatic mode.
- Assist in calibrating the moisture metering system
- Review the parts and service manuals and explain any procedures listed in the manuals

Note: Please allow two (2) weeks notice before start-up is to occur to ensure availability of a Field Service Technician.

Note: Start-up will be invoiced as follows: $110 per hour per 8-hour day
Monday thru Friday: $165 per hour beyond the first eight (8) hours Monday thru Friday: $165 per hour per 8-hour day

Saturdays: $220 per hour all work performed beyond 16-hours Monday thru Friday; and beyond eight hours on Saturdays,
and all Sunday hours: $250 per hour per 8-hour day for all Holidays. Any and all additional travel expenses including, but not limited to airfare, auto rental, lodging and meals will be invoiced to the customer at cost plus 20%.

ITEM G
<u>Not Included In Pricing:</u>
- Calibration of load cells by others - requires power to the control panel
- Venting of mixer by others
- Motor starters by others
- Freight
- Installation by others

Jim Spence
Regional Manager

DUSTMASTER® ENVIRO SYSTEMS Division of Mixer Systems, Inc.
190 Simmons Avenue • P.O. Box 10 • Pewaukee, WI 53072-0010 • Ph (262) 691-3100 • Fax (262) 691-3184 • www.dustmaster.com

TO: Sargent & Lundy
55 E Monroe Street
Chicago, Il 60603-5780

QUOTATION #: DM0883-11

DATE: September 7, 2011

VALIDITY: 30 Days

TERMS: 50% due at purchase order,
50% due before final shipment

CUSTOMER INQUIRY: Michael Rosen

DELIVERY: 6-8 weeks after receiving equipment from customer

Nebraska Public Power will ship back to Mixer Systems, Inc. either S/N 3195-00 or 3196-00 for brine water use upgrade. All freight charges will be the responsibility of Nebraska Public Power. NOTE: Mixer to be power washed clean, exterior and interior, prior to shipment back to Mixer Systems, Inc.

Mixer Brine Water Upgrade

ITEM A
Disassemble and Reassemble Mixer

- Remove existing rotating case, arms, and liners (existing motor and transmission will remain in place)
- Install new rubber liners and caulk
- Reassemble rotating case/mixing arms
- Install new brine rotary water header with FRP assemblies

ITEM B
Sandblast and Paint

- Sandblast interior of tank and rotating case and bottom of cover
- Interior coat to be painted Ceilcote 242AR Flakline (designed for corrosive environments)
- Exterior to be repainted standard DustMASTER paint with new decals

ITEM C
Brine and Water Supply Header

- Custom FRP pipe/fabrications
- Teflon lined butterfly disc
- 4" globe valve replace with FRP/composite compound ball valve
- Magflow meter Teflon lined
- Custom stand to attach header
- Our standard stainless steel clamps and hose to connect header assembly to rotary union on the mixer
- Custom FRP pipe assembly to combine brine with water header

ITEM D
Control Program Upgrade

ITEM E
Customer to re-use the following
- Inlet group
- Hydraulic power pack
- Discharge chute
- Load cell pedestal and load cells
- Control

NOTE; If during the disassemble/assembly process parts need to be replaced due to wear, Nebraska Public Power will be contacted with an itemized list and pricing.

TOTAL PRICE...\$118,390

Jim Spence
Regional Manager

ATTACHMENT E
AQUATECH QUOTATION FOR ZLD SYSTEM

Aquatech
International Corporation
One-Four Coins Drive
Canonsburg, PA 15317 USA
t) 724 746 5300
f) 724 746 5359
www.aquatech.com

August 15, 2011

Sargent & Lundy
55 East Monroe Street
Chicago, IL 60603-5780

ATTENTION: **Mr. Mike Rosen**

SUBJECT: **NPPD Gerald Gentleman Station FGD ZLD System**
AIC # 11-1104

Dear Mike,

Aquatech appreciates the request for quotation on this FGD ZLD system for the NPPD Gerald Gentleman Station. Here is the budget proposal per your request.

<u>FGD ZLD System:</u>

Since the FGD wastewater flow rate is very low (10 gpm), we recommend the following process: Lime Soda Softening Clarifier – followed by a – FCC (Forced Circulation Crystallizer).

Following is the preliminary scope of supply:

Description	Qty	Capacity	Design Criteria[2]	Detail Design	Supply
Pre-Treatment					
Lime Soda Softening Clarifier	1	100%	X	X	X
Lime Silo	1	100%	X	X	X
Lime dosing system	1	100%	X	X	X
Soda Ash Silo	1	100%	X	X	X
Soda Ash dosing system	1	100%	X	X	X
Coagulant dosing system	1	100%	X	X	X
Coagulant tank	1	100%	X	X	X

Aquatech
International Corporation
One-Four Coins Drive
Canonsburg, PA 15317 USA
t) 724 746 5300
f) 724 746 5359
www.aquatech.com

Description	Qty	Capacity	Design Criteria[2]	Detail Design	Supply
Flocculant dosing system	1	100%	X	X	X
Flocculant tank	1	100%	X	X	X
Sludge Transfer Pumps	2	100%	X	X	X
Sludge Thickener	1	100%	X	X	X
Filter Press Feed Pumps	2	100%	X	X	X
Plate & Frame Filter Press	1	100%	O	O	O
Forced Circulation Crystallizer					
FC Feed Tank and Mixer	1	100%	X	X	X
FC Feed Pump	1	100%	X	X	X
Flash Tank	1	100%	X	X	X
Foam Separator	1	100%	X	X	X
FC Heat Exchanger	1	100%	X	X	X
FC Vapor Compressor	1	100%	X	X	X
FC Recirculation Pump	1	100%	X	X	X
FC Distillate Hotwells	1	100%	X	X	X
FC Distillate Pump	2	100%	X	X	X
FC Antifoam Dosing Pumps (Skid Mounted)	2	100%	X	X	X
Process Piping, & Ducting within Battery Limit	Lot		X	X	X
Instruments	Lot		X	X	X
Manual, Control, and Relief Valves within Battery Limits	Lot		X	X	X
Belt Filter Press (BFP)					
BFP Feed Tank and Mixer	1	100%	X	X	X
BFP Feed Pump	1	100%	X	X	X

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One-Four Coins Drive
Canonsburg, PA 15317 USA
t) 724 746 5300
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www.aquatech.com

Description	Qty	Capacity	Design Criteria[2]	Detail Design	Supply
Belt Filter Press	1	100%	X	X	X
Electrical Equipment					
Motors (Compressor, Pumps, Mixers)	Lot	---	X	X	X
MV Switchgear	Lot	---	O	O	O
MV-LV Transformer	Lot	---	O	O	O
LV Motor Starters/VFD/MCC	Lot	---	O	O	O
L V Power Panel	Lot	---	O	O	O
Transformers	Lot	---	O	O	O
Aux Panel for MV Switchgear	Lot	---	O	O	O
Single Phase Power panel	Lot	---	O	O	O
Electric Lighting Equipment	Lot	---	O	O	O
Lightning Protection System	Lot	--	O	O	O
Electrical and Pneumatic Installation-On Skids Control & Instrument Wiring, Conduit, Power Wiring > 120 V, Cable, Conduit Skid Mounted Junction Boxes Pneumatic Tubing, Fittings, Trays	Lot Lot Lot Lot	---	X O X X	X O X X	X O X X
Electrical and Pneumatic Installation-Outside Skids Instrument Wiring, Cables, Trays Power Wiring, Cable, Conduit	Lot Lot Lot	---	O O O	O O O	O O O

Aquatech
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Canonsburg, PA 15317 USA
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www.aquatech.com

Description	Qty	Capacity	Design Criteria[2]	Detail Design	Supply
Control wiring/ cabling, trays, raceways Junction Boxes Pneumatic Tubing, Fittings, Trays	Lot Lot		O O	O O	O O
Structural Supports	Lot	---	X	X	X
Access Ladders, Platforms	Lot	---	X	X	X
Thermal Insulation	Lot	---	X	O	O
Heat Tracing	Lot	---	X	O	O
Prime Painting of Equipment	Lot	---	X	X	X
Manual, Control, and Relief Valves	Lot		X	X	X
Control System					
Control Cabinet/Panel	1	---	X	X	X
PLC System (c/w CPU, HW & SW etc)	Lot	---	X	X	X
Desk Top HMI (C/w Software)	1	---	X	X	X
HMI Operator Console	1	---	X	X	X
Printer for HMI Computer	1	---	O	O	O
Uninterrupted Power Supply (Panel Mounted)	1	---	O	O	O
Data Highway Communication to DCS	1	---	O	O	O
TESTING, SURVEYS, INSPECTION					
Shop Hydrostatic Testing	Lot				X
Vessel Certification to ASME Section VIII	Lot				X[3]
QC Inspections	Lot				X
Non-destructive Examination	N/A				
Shop Performance Testing	N/A				
Field Performance Testing	Lot				X

From Innovation Flows Leadership

Aquatech
International Corporation
One-Four Coins Drive
Canonsburg, PA 15317 USA
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www.aquatech.com

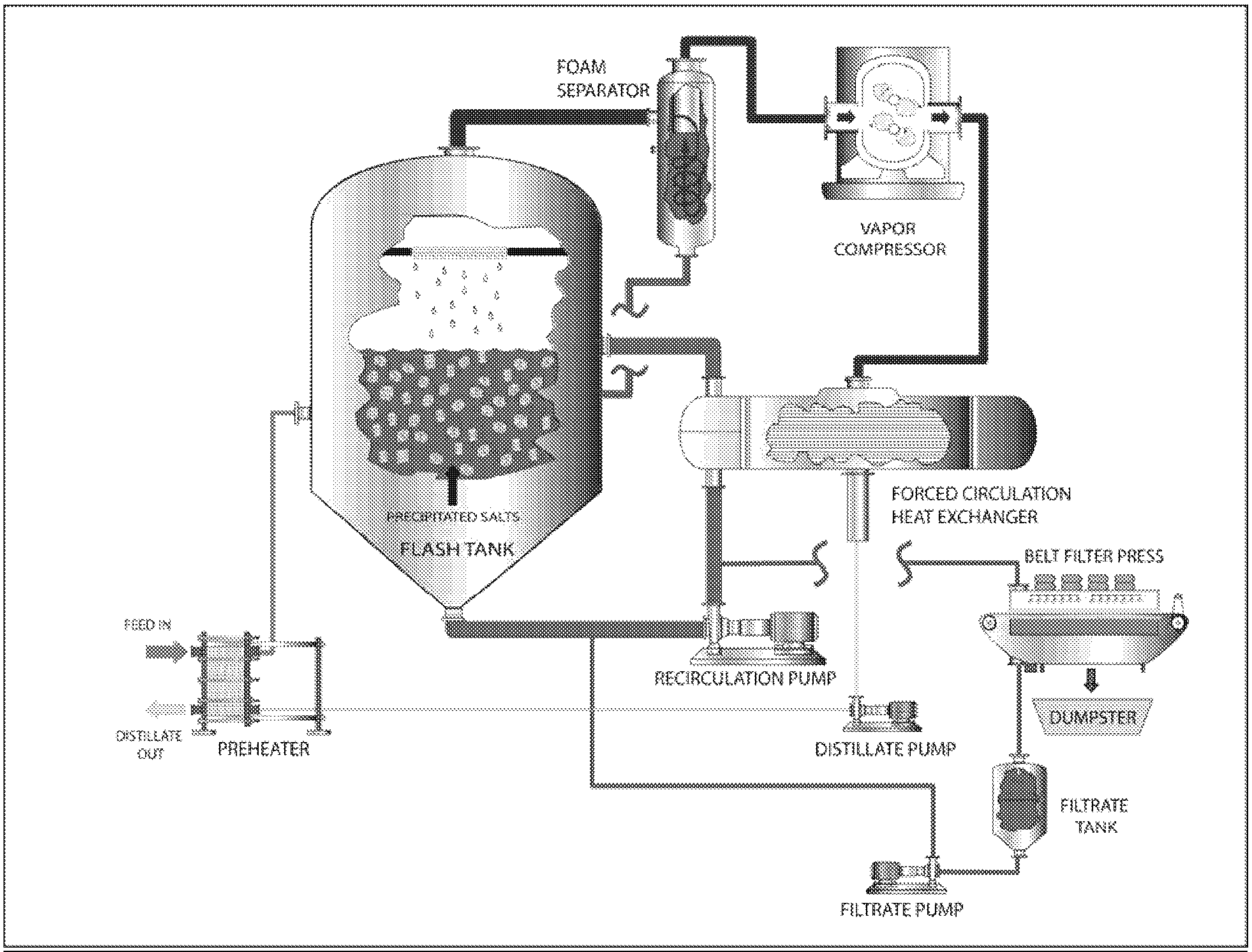
Description	Qty	Capacity	Design Criteria[2]	Detail Design	Supply
CONSTRUCTION					
Temporary Facilities	Lot		O	O	O
Site Grading	Lot		O	O	O
Civil/Foundation Work	Lot		O	O	O
Buildings, Architectural, HVAC	Lot		O	O	O
Job Site Unloading, Storage, and Protection	Lot		O	O	O
Installation/Erection Labor, Materials, and Equipment	Lot		O	O	O
Electrical Installation Labor, Materials, and Equipment	Lot		O	O	O
SERVICES					
Packing and Marking for Shipment	Lot				X
Installation Supervision	Lot				Option
Start-up and Performance Testing Supervision	Lot				Option
Training of Permanent O & M Personnel	Lot				Option
Permits	Lot				O
Drawings and Manuals (10 Sets)	Lot				X
CONSUMABLES					
Commissioning, Testing Spare Parts	Lot				X
First Fill of Permanent Lubricants and Chemicals	Lot				O
MV and LV Electric Power, Cooling Water, Steam, demin water, for Construction, Checkout and Testing, Start-up, Performance Testing, and Operation	Lot				O

Aquatech
International Corporation
One-Four Coins Drive
Canonsburg, PA 15317 USA
t) 724 746 5300
f) 724 746 5359
www.aquatech.com

Notes:

1. Design criteria do not include detail drawings or Bills of Material. Design criteria may be specified in the Technical Manual. They do not incorporate local laws, codes, or regulations not known to Aquatech.
2. Scope of supply indicated above is for supply proposal only. Please refer another section for detail scope of work pertaining to the construction/installation part.
3. Please refer to Aquatech inspection & test plan (ITP) for inspection and test details included in the scope.
4. Only pressure vessels with design ratings above 15 psig will be stamped in accordance with Section VIII of the ASME Code.

BUDGET PRICE (Equipment supply only): **US $ 4,900,000**
Ex-works Supply



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EXCLUSIONS:

The scope of supply by Aquatech International Corporation is as defined in this proposal. The work to be performed in the field by others is:

1) Receive, unload, store and install the equipment to be supplied by Aquatech International Corporation.
2) Supply & Install inter-connecting piping and pipe supports outside skid envelopes.
3) Install electric power supply connections and feeders to all junction boxes and the control panel / Motor terminals, heaters.
4) Supply of MCC. VFD or soft start for pumps. Single phase local starters would be provided by Aquatech.
5) Carry out field erection, installation and construction.
6) Furnish and install heat tracing and/or insulation, where and if required.
7) Perform necessary civil or structural work such as foundations, embedded steel, anchor bolts, clips, etc.
8) Furnish and delivery the following utilities to each of the necessary skids:
9) 460/3/60 Hz electrical power
   120/1/60 electrical power
   80 psig, dry, oil-free plant air
10) The equipment has been factory tested and proven leak proof prior to shipment. However, during transportation, connections may loosen and leak when first started up. It is the installer's responsibility to check such connections prior to start up and tighten as necessary.
11) All buildings, sun sheds, and weather protection shelters for housing various equipment.
12) Any item not specifically included in our proposal.

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Aquatech's preference is to provide our equipment ex-works. If freight is required in our scope we request it be paid at actual. Typical equipment deliveries for this type of system are 52 to 60 weeks from PO depending on the final scope.

The pricing information supplied is based on recent proposals and represents an accuracy of +/- 15%. The above pricing is based on Aquatech standard equipment including design, documentation, component selection, quality control and terms and conditions. Technical Support services at site are not included in our above offer and can be provided at per diem rates. Please see a copy of those rates attached.

I look forward to your questions, concerns and/or comments.

Best Regards,

Ashwin Thakkar
Regional Sales Manager
T) 905-831-4441
C) 416-820-2567
thakkara@aquatech.com

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Domestic Rates and Terms – Field Services

Straight Time Rate

Field erection/Construction supervisor	**$ 1,000.00 for an 8 hour work day**
Startup supervisor	$ 1,100.00 for an 8 hour work day
Training engineer	$ 1,400.00 for an 8 hour work day

Expenses

Air ticket from current location to the site	Actual cost of ticket (economy class)
Hotel room rent and tax at site	Actual cost
Rental car/ Taxi at site for engineer to commute to work	Actual cost
Food, incidental/sundry expenses	$ 100.00 per day.

Terms:

1. Tickets/invoices will be attached to the invoice for air ticket, room rent and rental car.
2. Bills/receipts not required to be produced for food and incidental/sundry expenses.
3. The purchaser will not be responsible to reimburse expenses related to entertainment.
4. The above rates will be paid for travel time (8 hours each way) and standby time. Whereas the time worked in excess of 8 hours and for time worked on holidays, the basis of calculations will be as per Clause "B" (Definitions) of Appendix A to Section III.

{In Archive} RE: Aquatech ZLD Proposal for Gerald Gentleman
MICHAEL D ROSEN to: Ashwin Thakkar 08/24/2011 08:46 AM
Cc: CHRISTOPHER.D.HORNISH, PAUL.HOORNAERT, "Patrick Randall", "Roger Blomquist", "Scott Blomquist", STEVEN.R.PASIMENI, WAYSHALEE.A.PATEL
Archive: This message is being viewed in an archive.

Hi Ashwin,

Thank you for the attached clarification regarding the interconnecting piping costs.

From: "Ashwin Thakkar" <thakkara@aquatech.com>
To: <MICHAEL.D.ROSEN@sargentlundy.com>
Cc: <CHRISTOPHER.D.HORNISH@sargentlundy.com>, <STEVEN.R.PASIMENI@sargentlundy.com>, <PAUL.HOORNAERT@sargentlundy.com>, <WAYSHALEE.A.PATEL@Sargentlundy.com>, "Patrick Randall" <randallp@aquatech.com>, "Scott Blomquist" <sblomquist@rmbsales.com>, "Roger Blomquist" <rblomquist@rmbsales.com>
Date: 08/23/2011 10:07 PM
Subject: RE: Aquatech ZLD Proposal for Gerald Gentleman

Mike:

I got your voicemail as well regarding this request.
I would recommend to add roughly ~ $ 480k to include the IC piping.

Regards,
Ashwin

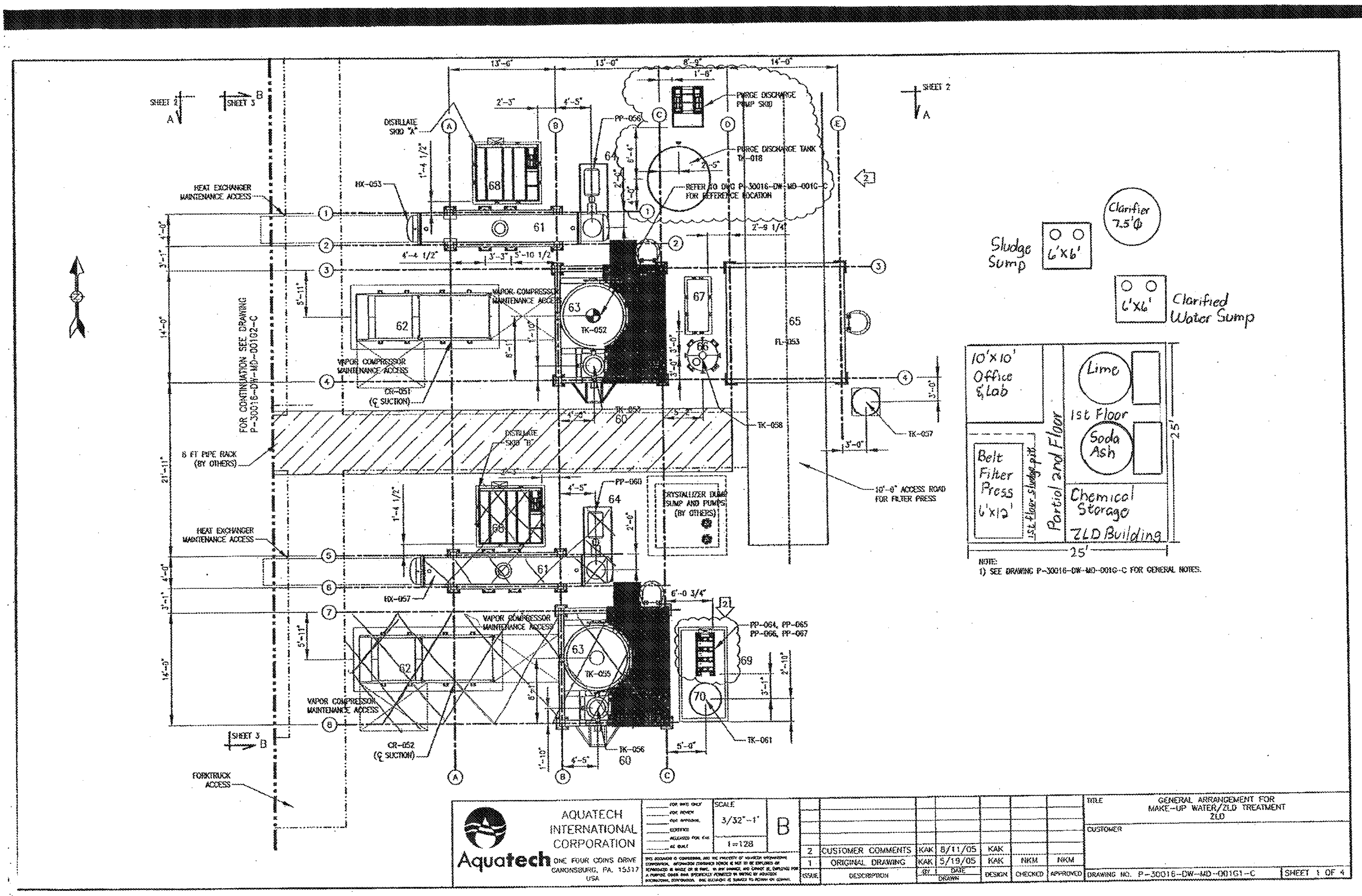
From: MICHAEL.D.ROSEN@sargentlundy.com [mailto:MICHAEL.D.ROSEN@sargentlundy.com]
Sent: Tuesday, August 23, 2011 1:38 PM
To: Ashwin Thakkar
Cc: CHRISTOPHER.D.HORNISH@sargentlundy.com; STEVEN.R.PASIMENI@sargentlundy.com; PAUL.HOORNAERT@sargentlundy.com; WAYSHALEE.A.PATEL@Sargentlundy.com
Subject: Aquatech ZLD Proposal for Gerald Gentleman
Importance: High

Hi Ashwin,

Our project team briefly reviewed your budgetary proposal for the ZLD system and noticed in the list of exclusions that interconnecting piping and supports between skids was not in your scope of supply. We are currently preparing our estimate for the overall project and would prefer that you included all interconnecting piping within the battery limits of your process in your scope of supply. Can you advise what the cost adder would be to include all of the interconnecting piping in your scope of supply? Thank you.

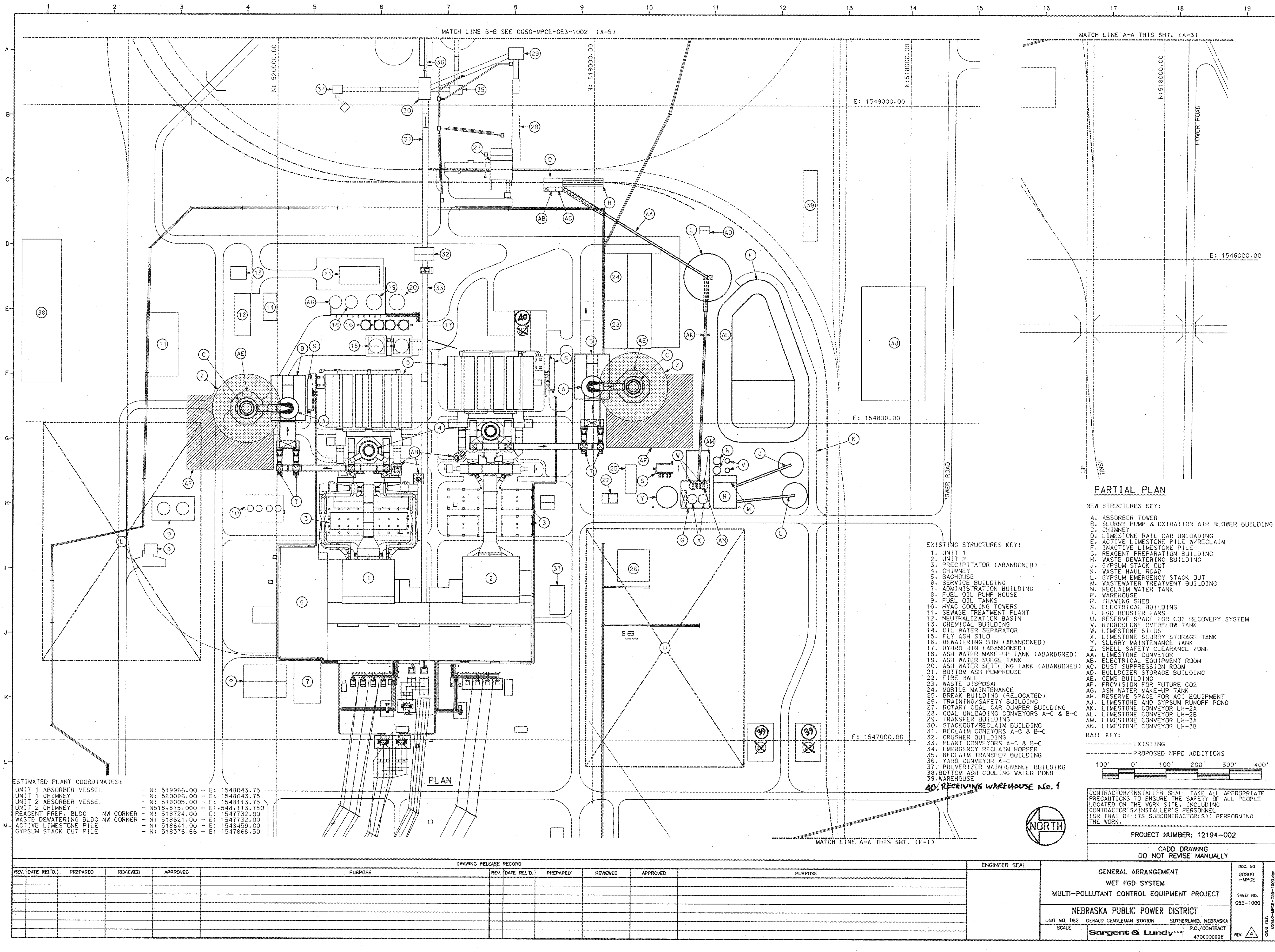
ATTACHMENT F
ZLD AND SITE GENERAL ARRANGEMENT DRAWINGS

Question 1



For Reference Only

Question 1



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